

**Testimony of Mark Deadrick on the duPont Aerospace DP-2 Program
June 12, 2007**

Introduction:

Good Morning, distinguished members of Congress and guests. My name is Mark Deadrick; I am a Mechanical Engineer, small business owner, and former employee of duPont Aerospace Co. Inc. (DPA). I have been asked to join this hearing today to describe my experiences while working at DPA, including technical challenges and project management shortcomings.

Work History:

My initial contact with DPA was in November or December of 1988. While a third year Engineering student at the University of California at San Diego, I replied to a job posting for a Mechanical/Aerospace Engineer. I had an interview with DPA President, Anthony A “Tony” duPont and former Vice President Anthony C. “A.C” duPont and expressed my interest in model making and radio controlled aircraft. I was quickly offered a job as an intern/model maker. The model shop was located at Gillespie Field in El Cajon, California. Along with A.C. duPont, I was involved with fabricating a full scale wooden mockup of the proposed DP-2 Aircraft. Later, in the summer of 1989, the facility was moved to Brown Field near the Mexican border.

Through the period of 1988 until I graduated from college, I predominantly worked on the DP-2 mockup, but worked from time to time on other projects, including demonstrator models for the National Aerospace Plane (NASP), and a 50% scale DP-2 (DP-1) wing spar. During the period from January 1992 until October 1994, I worked as a full time employee.

In October of 1994, I took a job in metro Detroit, Michigan to work as an engineer in the automotive industry. As my brother Tom Deadrick had been employed as a fabricator at DPA since 1996, I had occasional contact with the company and had visited at least once or twice. Tony had asked me twice in the preceding years to come back to work on both the full size thrust vectoring system, and the current half scale demonstrator.

In January of 2002, I contacted Tony DuPont to see if he had an opening for me, and he agreed to hire me on the spot. I started at the end of February, and was initially responsible for the fabrication of the current, second-generation fuselage.

The fuselage had previously been the responsibility of at least two engineers who had left the company. The design had been completed for the most part, so I took the design into prototype, which would take place at a remote facility based out of Mississippi State University’s Rappett Flight Laboratory. DPA had employed two technicians to prepare tooling and fabricate components, including the fuselage, empennage, and wing components.

Over the following two years, I would travel to Mississippi at least 4-6 times a year, until the prototype fuselage was completed.

In 2003 I was named Manufacturing Engineering Manager, and was in charge of composite fabrication, and aircraft assembly. Included in my duties were advanced surface CAD modeling of the engine inlets and shrouding, and all composite tooling designs. I would also create operator lay-up manuals for composite fabrication, work on advanced manufacturing processes, and organized incoming composite materials destructive testing.

In June of 2005, I left the company, as I had created my own product development company, 3dyn, llc, focusing on composites design and manufacturing. I maintain this company today, with customers in aircraft, space, automotive, and consumer products.

Technical Issues:

In regards to the DP-2 program, many technical challenges have arisen. As is well documented, vertical lift, fixed wing aircraft are likely the greatest challenge for aircraft designers. In no way is the problem a trivial one.

The features unique to the DP-2 are focused on the thrust vectoring system, used for vertical or short takeoff. A full-scale test unit, which had been designed and built in the mid 1990s, had been tested in the Fall of 1996, and ended with a structural failure of the cascade sidewall attachment to the pitch control actuator. This attachment keeps the cascade, or the main structural member of the thrust vectoring system, from freely rotating. Without support, the system would become unstable, and may come into contact with the cabin floor, depending on the thrust level of the engine. I was not involved with the design, fabrication, or testing of this system, but I have seen the damaged components and recognized the potential failure mode.

With respect to technical issues that I have witnessed in design, fabrication, and test, the major problems still exist in the thrust vectoring system. The challenges particularly focus on the mechanical control system, materials selection and fabrication techniques, and exhaust air temperature.

Whether needed or not, the mechanical control system consists of numerous levers, bell cranks, bearings, push-pull rods and fasteners. Even with near zero manufacturing tolerances and infinitesimal flex (which were not met) excessive play in the system yields response critical hysteresis and free play. Nyquist and Bode plots from the bandwidth testing were conducted during the test program and should be available for review. Without a refined mechanical control system, both automated and pilot controlled hover will be very difficult.

Numerous structural failures have also hindered the program. Some airframe failures have been minor and can be addressed. Other failures, particularly in the thrust vectoring

system and its integration with the airframe, have caused serious downstream damage, and have the potential for bodily harm.

Failures involved with the turning vanes, the composite, airfoil-shaped, lateral blades that direct exhaust thrust from horizontal to vertical downward, have been one of the Achilles heels of the program. In my view, buckling failures of the turning vanes, nearly always in the center of the exhaust cone, are the result of having been subjected to temperatures above the glass transition temperature of the material, or the level at which the resin will no longer support a reasonable load. The composite material used in the turning vanes, as well as the entire thrust vectoring system is LTM110, and cyanate ester / carbon fiber prepreg manufactured by the Advanced Composites Group (ACG). While sold as a high-temperature material, ACG product literature states that it has a maximum glass transition temperature 572 degrees Fahrenheit. It is also noted that the material is typically used for spacecraft interior equipment, radomes, and high temperature, non-structural engine parts.

Data published in the Pratt & Whitney 535A service manual state the temperature of the exhaust gas at approximately 4 feet behind the engine are on the order of 700 to 800 degrees Fahrenheit, beyond the glass transition temperature of the LTM110 material. I do not know if exhaust gas temperature readings were ever recorded as the testing engineers were not allowed to instrument the turning vanes with thermocouples during my time of employment. I believe this is a major issue that should be addressed if it has not been already.

Various structural failures have occurred over the course of the project, some minor, but at least one major, life risking failure. In November of 2004, a chained down test, in which the plane is not allowed to elevate, was conducted with test pilot Larry Walker in the cockpit and at the controls of the engine throttle levers. As I recall, Larry was testing either the engine acceleration response, or deflection of the thrust vectoring cascade, when a major structural failure occurred in the pivot attachment of the two cascades, in which a large piece of titanium was ripped free of its composite encapsulation, allowing the cascades to rotate beyond the horizontal stow position, crashing through the cabin floor, pushing the pilot's seat upward and forwards. I recall Larry Walker's helmet striking the ceiling of the fuselage. I remembered that just a day or two prior, Test Director Howard Northrup was sitting in the fuselage, measuring control movements, in the area where the cascades crashed through the floor. In my opinion, he would have been seriously injured or possibly killed if he was in this position during the failure.

An investigation into this failure lead to the determination that there was a failure in the adhesion of the carbon fiber to the titanium. I believe that once again, a material not suited for structural use was neither correctly specified, nor correctly processed. This area had been repaired numerous times due to delamination of the carbon fiber face sheets to the honeycomb core.

Management Issues:

The management structure at DPA is nearly vertical. Tony duPont is the President, his brother Rex duPont is Vice President, and Tony's wife Carol duPont (formerly the Vice President) is the Director of Administration. Only temporarily during my employment was there a Chief Engineer, who left shortly following the major failure of November 2004, after less than a year in that position.

Upon my re-hire in 2002, I believe there were 10-12 full time engineers on staff, but 2 left the company within the first 2 months. These positions were backfilled, but over the course of the next 2.5 years, the turnover had been such that I had been there longer than all but 2 other Engineers. Most departures were to other aerospace companies in the area. I think there was close to 2 times turnover, with at least 15-20 Engineers leaving in the 3 years I was with the company. The engineering staff consisted of varying levels of experience, with a large portion of newly graduated engineers, who typically would work a year or two and move to a larger company. This situation would cause great discontinuity in the project, and ever decreasing familiarity with the total program.

Tony duPont's management style was very steadfast. He did not readily accept conflicting opinions. This does not mean he might not eventually accept them, but this caused much disillusionment among the engineering staff. The general rule of thumb was, Tony gets his way.

There was not a meaningful product development strategy or process. Engineers would typically work on individual projects, with little to no communication between them. Without a dedicated engineering manager, no one would take full development responsibility for the aircraft.

Ethical Issues:

Following the major failure of the thrust vectoring system, I found myself ready to be clear of any future such events. I did not feel that repairs to the system were being conducted in a proper manner. The materials selected for the thrust vectoring system would continue to fail, the process of fabrication was still limited due to insufficient equipment, and the fabrication personnel had limited experience.

As a new, lighter, fuselage would be introduced with the repairs, a change to the attachment of the wing would be conducted at the same time. During this time, there was a worldwide shortage of carbon fiber material. DPA had ordered, but not yet received material to make a thick attachment flange on the wing, but the delays would jeopardize the time get the plane back to test, with a ceremonial completion date of June 6, 2005 (it was now May 2005 and the plane was not close to completion). There was material in the storage freezers that had been quarantined due to suspect fiber quality. It was Tony duPont's directive, against my advice, to use this material to immediately begin

fabrication of the wing mounting flange. With this decision, I concluded my professionalism was not respected, and I set plans to leave the company.

Tony and Carol duPont had been on vacation, and I was determined to leave the company before they returned. With poor discretion, I announced my intention to leave to a few other employees, and the word got to Tony while traveling. Tony called me on my cell phone, mentioned he heard I was leaving the company, and asked where I was going. Having already lined up a short term consulting gig, I told Tony I was going nowhere, that I felt the aircraft was unsafe, and I did not want to continue working for the company. His reaction was to tell me to immediately leave the company, collect my last paycheck and save the company any more damage. Tony then proclaimed that I was responsible for many Engineers leaving the company. I returned the compliment that he, and he alone was responsible for the engineering department's rapid decline. (As a note, during this time at least 6 engineers had quit over a 6 month period, including the Chief Engineer.)

Conclusions:

As a parting statement, I feel that the DP-2 program has some technical merits, but a series of poor engineering judgments, mismanagement, engineering department morale, limited fabrication facilities and fabricator expertise all lead to a marred program. At the current fund level, it will be nearly impossible to achieve any meaningful results. I feel the program should be either funded to a useful amount, the plane developed from scratch, with a new management and engineering team, or the program should be cancelled at once. At its current capacity, duPont Aerospace is not capable of developing a sound, safe, and flight worthy aircraft.

Thank you for giving me the time to express my observations and impressions of the program. I rest assured that a proper decision will be made as to the future of the DP-2.

A handwritten signature in black ink, appearing to read 'Mark Deadrick', with a large, stylized initial 'M' and 'D'.

Mark Deadrick